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THE TACHINID GENERA *PSEUDOCHAETA* AND *PHAENOPSIS* IN NORTH AMERICA, (DIPTERA) *

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Flies belonging to the genus *Pseudochaeta* are widely distributed in the United States and southern Canada but the allied genus *Phaenopsis* has not been recorded hitherto from North America. A recent study of the accumulated material in these genera has brought to light a number of distinct species, which are described below. I am especially indebted to C. F. W. Muesebeck, Dr. R. H. Beamer and A. R. Brooks for the loan of material. Types of the new species are in my collection.

Coquillett established *Pseudochaeta* in 1895, with *argentifrons*, new, as the type species (Proc. Acad. Nat. Sci. Phil., 309). Two years later he described a second new species, *P. pyralidis*, from a female specimen reared from a pyralid at Washington, D. C. (Revis. Tachinid., 1897, 116). Although the latter seems doubtfully congeneric with *argentifrons*, it is included here pending knowledge of the unknown male characters. *Pseudochaeta antennalis*, described by the writer in 1921 (Ann. Am. Ent. Soc., 14, 330) is still less closely allied to the genotype and clearly falls outside the genus as here considered. The last species assigned to *Pseudochaeta*, is *canadensis*, recently described by Brooks (Can. Ent., 77, 1945, 93).

The history of *Phaenopsis* is brief. The genus was described by Townsend in 1912, with *arabella*, new, from Sullana, Peru, as the type and sole original species (Proc. U. S. Nat. Mus., 43, 362). Failing to recognize the type species three years later, Townsend described it again as *Dimasicera nitida*, new genus and species, from the same locality (Jr. N. Y. Ent. Soc., 23, 1915, 62). Aldrich, who saw both types in the U. S. National Museum, pointed out this synonomy to me (*in litt.*, 1923) and presumably also to Townsend, who eventually published it in 1941 (Manual of Myiology, Part II, 310). In external adult characters, *Phaenopsis* is strikingly similar to *Pseudochaeta* though readily distinguished by the items mentioned in the accompanying key.

The type series of *Pseudochaeta argentifrons* Coq. is in the U. S. National Museum. I have not seen it. The seven specimens which it originally included were collected at Charlotte Harbor, Florida (Mrs. A. T. Slosson) and Los Angeles, California (D. W. Coquillett). It appears likely that the series included a mixture of species from which *argentifrons* can hardly be recognized by means of the description. Townsend based his redescription of the genus upon the Florida specimens exclusively, citing Charlotte Harbor as the type locality. In the material available for study there is one specimen from the U. S. National Collection labeled "Ch. Hbr. Fla., Collection Coquillett", which, at least, is of the same origin as the type, if not actually one of the type series. It is here accepted as the true *argentifrons* and the following generic characters of the male are taken from this specimen.

Generic characters of Pseudochaeta. Head one-third wider than high, arcuate frontal profile subequal length of receding facial, antennal axis shortly above eye middle, well over one-half head height and twice length of vibrissal; clypeus deeply sunk; facial ridges subvertical, divergent downward, bristled to near upper fourth; epistoma short, as wide as clypeus; vibrissae on oral margin near lower edge of head; vertex about one-third head width in both sexes, front

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hardly widening forward; ocellars vestigial or absent; two reclinate orbitals in both sexes besides two proclinate in female; frontals in a single row with anterior two or three bristles beneath base of antennae; outer verticals weak in female, vestigial in male; frontal vitta extra narrow and at times linelike above in male; about one-fourth parafrontal width in female; antennae subequal length of face, third segment three to five times length of second; arista bare, middle segment short, thickened on basal third or less; parafacial bare, strongly narrowed downward; proboscis short, labella large, fleshy; palpi moderately widened apically; cheek about one-twelfth eye height; eye large, reaching to vibrissal level, thinly to very sparsely short-haired; occiput flat, clothed with short pale hairs. Thoracic chaetotaxy: Acrostichal 3, 3; dorsocentral 3, 4; intraalar 3; supraalar 3; presutural 2; notopleural 2; humeral 2-3; posthumeral 2; postalar 2; intrapostalar strong; sternopleural 2; pteropleural 1 (small); scutellum with 3 lateral, 1 discal and 1 upturned apical pair; infrascutellum normally developed; prosternum haired; propleura and sides of postnotum beneath calypters bare. Wings hyaline, rather short and broad; first posterior cell narrowly open shortly before wing tip; third vein with one or two hairs near base; bend of fourth vein obtuse, without stump or fold; hind cross vein slightly nearer bend than small cross vein; last section of fifth vein over one-third length of preceding; costal spine minute. Legs moderately stout, tarsi shorter than tibiae; claws and pulvilli short in both sexes. Abdomen short ovate, as broad as thorax; basal segments each with one pair of median marginals, third with a complete marginal row; anal segment bearing irregular discals on apical half above and a scarcely differentiated marginal row; sternites covered; female genitalia not adapted for piercing. Length 4.5–5.5 mm.

The above listed characters, with a few exceptions, apply also to the type species of *Phaenopsis*. The latter has three postsutural dorsocentrals, wider frontalia and the eyes more thickly haired in both sexes. There are other minor differences which may be gleaned from the following specific description.

KEY TO SPECIES OF *PSEUDOCHAETA* AND *PHAENOPSIS*

1. Three postsutural dorsocentrals; eyes thickly haired ..... *Phaenopsis* 10
   Four postsutural dorsocentrals; eyes thinly short-haired *Pseudochaeta* 2.
2. Palpi black, tips at times slightly reddish ..... 3.
   Palpi wholly yellow or at most brownish basally ..... 6.
3. Parafrontals silvery; frontal vitta obviously narrower than parafrontal ..... 4.
   Parafrontals with opaque gray pollen tinged with yellow; frontal vitta subequal parafrontal width in both sexes; last three abdominal segments pollinose or subpollinose to hind margin, Texas ..... *Pseudochaeta frontalis* n. sp.
4. Abdomen wholly black in ground color ..... 5.
   Abdomen red-tipped; three reclinate orbitals set nearly in frontal row; apical scutellars hairlike, directed horizontally backward; abdominal hairs rather long and erect (male only), Texas ..... *P. clurina* n. sp.
5. Arista thickened on basal half, abdomen with narrow and sharply limited pollen bands on basal margin of segments two to four; latter bearing a well differentiated row of marginal bristles, Texas ... *P. marginalis* n. sp.
   Arista thickened on basal third; second abdominal segment in male and last three in female with pollen extending thinly to hind margin; anal segment without a differentiated marginal row, Ohio, Texas ..... *P. siminina* n. sp.
6. Abdominal segments two to four shining black on posterior fourth or more ..... 8.
   Abdominal segments two to four pollinose or subpollinose to hind margin ..... 7.
7. Sternopleurals four; scutellum red on apex; abdomen black in ground color (female only), Washington, D. C., Texas ... *P. pyralidis* Coquillett.

Sternopleurals two; scutellum black, fourth abdominal segment red (female only), Texas ..... *P. finalis* n. sp.

8. Legs and abdomen black, venter may be reddish 9
Legs except tarsi and abdomen wholly red; latter translucent, with silvery pollen on narrow basal margin of intermediate segments (female only), Texas, Florida ..... *P. perdecora* n. sp.

9. Abdominal segments two and three pollinose on basal half or more; third antennal segment three to five times second; male forceps moderately long, distinctly wider than thick, U. S. widespread ..... *P. argentifrons* Coquillett.
Abdominal segments two and three pollinose on basal third or less; third antennal segment five (female) to eight (male) times second; male forceps extra long and slender, straight on ventral edge nearly to tip, Canada to Texas and Arizona ..... *P. canadensis* Brooks.

10. Squamae brown; frontal vitta narrowed towards vertex; third antennal segment four (female) to seven (male) times second, Texas ..... *Phaenopsis venusta* n. sp.
Squamae white with a tawny tinge; frontal vitta equibroad on entire length; third antennal segment three to five times second, Peru ..... *P. arabella* Townend.

Pseudochaeta pyralidis Coquillett

Pseudochaeta pyralidis Coq. Revis. Tachinid., 1897, 116-17.

The species was described from a female specimen, which I have not seen. No additional material has been recorded hitherto. The two females included here differ from the description of the type in only a few minor points as indicated below.

Female. Front at vertex 0.36 of head width and barely widening downward; head pollen gray with a distinct tawny tinge; frontal vitta linelike above in one specimen but nearly one-half parafrontal width in the other; verticals two pairs, outer nearly as long as inner; ocellars vestigial or absent; frontals not very large, lower two or three bristles beneath antennal base; two reclinate and two proclinate orbitals; antennae subequal length of face, short second segment tinged with red, third black equibroad from base to rounded tip, nearly five times longer than second; arista black, bare, moderately thickened on slightly over proximal half, basal segments short but distinct; clypeus well sunk; facial ridges bristled to near aristal level; vibrissae on oral margin; parafacial bare, narrowed downward but not pinched out on lower extremity; proboscis short, thick, labella large; palpi yellow, spatulate; eye large reaching to vibrissal level, sparsely but distinctly haired; cheek gray pollinose, in profile about one-fifteenth eye height; occiput flat, gray pollinose, clothed with pale hairs.

Thorax black, gray pollinose, with four dorsal vittae before suture and five behind; scutellum reddish at least on apex, dusted with changeable gray pollen above; chaetotaxy as in *argentifrons* except four sternopleurals and the apical scutellars nearly horizontal; prosternum with several long hairs on outer margin; propleura and postnotal slopes bare; infrascutellum normally developed. Wings gray hyaline, reaching well beyond tip of abdomen; veins yellowish, third with two or three hairs near base; first posterior cell narrowly open well before wing tip: bend of fourth vein subrectangular, without stump or fold; hind cross vein slightly nearer bend than small cross vein; last section of fifth vein less than one-third length of preceding section; costal spine minute; epaulets blackish; calypters opaque white. Legs black, rather short but not stout, hind tibia thickly ciliate with one slightly longer bristle in row; mid tibia with two stoutish bristles on outer front side near middle; fore tarsus slender, shorter than tibia; claws and pulvilli short.

Abdomen short, ovate, black with sides and venter more or less reddish, wholly gray pollinose above, showing a narrow median vitta in most views, median

marginals hardly differentiated on first segment but a stoutish pair on second; last two segments each with a marginal row and irregular discals on apical half or more above on last; genitalia retracted, without piercer, sternites covered. Male unknown.

Length, 7–8 mm.

Holotype female, Washington, D. C., in the U. S. National Museum.

Redescribed from two female specimens from College Station, Texas, May 17, 1943, and May 16, 1944 (H. J. Reinhard).

In external characters the present species differs from the genotype mainly in chaetotaxy but in other respects the agreement seems close enough to include it here provisionally pending knowledge of the male characters.

Pseudochaeta finalis n. sp.

Female. Front at vertex 0.27 of head width (one specimen), gradually widened to 0.37 of same at antennal base; head subsilvery pollinose with a slight yellowish shade on parafrontals; frontal vitta deep velvety brown, at middle about one-half parafrontal width; two proclinate and two reclinate orbitals; ocellars absent; verticals one pair (inner) developed; frontals in single row, obsolete above mid front, lower two or three bristles below antennal base; clypeus moderately sunk; facial ridges bristled to near upper fourth; parafacial bare, narrowed below; antennae wholly black, slender third segment reaching nearly to oral margin, about five times longer than second; arista black, bare, thickened on basal fourth, middle segment short; vibrissae on oral margin; proboscis short, labella large; palpi yellow, spatulate; cheek gray pollinose, about one-twelfth eye height; eye very sparsely short-haired; occiput flat, black, thinly gray pollinose, clothed with pale hairs intermixed with black ones above.

Thorax black, gray pollinose, vittate above; scutellum black, with rather uniform gray pollen extending from base to apex; chaetotaxy as in *argentifrons;* prosternum setose; propleura and postnotal slopes bare. Wings gray hyaline; third vein with two hairs near base, others bare; first posterior cell narrowly open shortly before extreme wing tip; bend of fourth vein obtuse, rounded, without stump; last section of fifth vein short; hind cross vein a trifle nearer bend than small cross vein; epaulets blackish; costal spine minute; calypters opaque white with a slight tawny shade. Legs black; hind tibia subciliate; mid tibia with one antero-lateral bristle; fore tarsi slender, subequal length of tibia; claws and pulvilli short.

Abdomen black with sides, venter and anal segment red, last three segments wholly gray pollinose above; second segment with one pair of median marginals, third with marginal row; anal segment with submarginal row and erect bristly hairs over most of upper surface; hairs on intermediate segments depressed; genitalia not adapted for piercing; sternites covered. Male unknown.

Length, 5 mm.

Holotype female, College Station, Texas, April 28, 1943 (H. J. Reinhard).

Pseudochaeta frontalis n. sp.

Male. Front at vertex 0.29 of head width (one specimen), equibroad to base of antennae; parafrontals gray pollinose tinged with yellow, moderately black-haired before vertex; frontal vitta deep brown, equibroad on entire length and subequal width of parafrontal; two reclinate orbitals about midway between frontal row and eye margin; outer verticals not differentiated; ocellars absent; frontals in a single row, rather small but distinct on upper half, becoming somewhat stronger downward, lower two or three beneath antennal base; parafacial narrow, bare, subsilvery; antennae wholly black, third segment moderately broad, reaching to oral margin, four or five times length of second; arista black, bare, thickened on basal fourth or less, proximal segments short; clypeus moderately sunk; facial ridges divergent downwards, bristled to near upper third; vibrissae large, on oral margin; proboscis short, with large fleshy labella; palpi jet black, moderately widened apically; cheek gray pollinose, sublinear in profile; eye large

extending slightly below aristal level, nearly bare or with sparse short inconspicuous hairs; occiput flat, gray pollinose on black ground color, thinly pale pilose.

Thorax black, grayish pollinose, showing a slight yellow shade on mesonotum, latter vittate; scutellum black; chaetotaxy as in *argentifrons;* prosternum setose; propleura and postnotal slopes bare. Wings gray hyaline; third vein with two hairs near base, others bare; bend of fourth vein obtuse, without stump; hind cross vein oblique, about midway between bend and small cross vein; first posterior cell narrowly open well before wing tip; last section of fifth vein two-fifths length of preceding section costal spine vestigial; epaulets black; calypters translucent white. Legs black, rather weakly bristled; hind tibia ciliate; mid tibia with one bristle on outer front side beyond middle; tarsi slender, claws and pulvilli short.

Abdomen slightly elongate, tapered apically, black, last three segments above pollinose or subpollinose to hind margin, showing a narrow dark median vitta in most angles; basal segments each with a pair of median marginals but small on first; segments three and four with a marginal row, besides numerous discals and erect bristly hairs over most of upper surface of last; first genital segment short, infuscated; second much larger, subglobose or convex above, wholly red; forceps long and slender, nearly straight in profile; accessory process nearly as long as forceps, extra slender beyond base, tip acute; fifth sternite broadly and deeply incised, lobes black, with a few long slender hairs on inner margin.

Female. Front at vertex 0.28 of head width (one specimen), widening a trifle to antennal base; outer verticals one-half as long as inner ones; two proclinate and two reclinate orbitals; third antennal segment three times length of second; palpi black with extreme tips tinged with red; frontal vitta slightly narrowed before vertex, not quite equal parafrontal width; abdomen rather short, ovate, with somewhat thicker pollen; otherwise, similar to male.

Length, 6–6.5 mm.

Holotype male and *allotype* female, College Station, Texas, May 15 and 26, 1943 (H. J. Reinhard).

Pseudochaeta perdecora n. sp.

Female. Front at vertex 0.27 of head width gradually widening to 0.39 of same at antennal base; parafrontal blackish on upper half, with subsilvery pollen becoming thicker downward, sparsely beset with short black hairs; frontal vitta deep red, much narrower than parafrontal; two proclinate and two reclinate orbitals; inner verticals straight, outer pair small but differentiated; ocellars absent; frontals in a single row, weak or hairlike above becoming stronger downward, with two or three beneath base of antennae; parafacial silvery, bare, strongly narrowed or pinched out on lowed extremity; facial ridges subvertical, bristled to near level of arista clypeus deeply sunk; epistoma short, not narrowed from clypeus; vibrissae on oral margin; antennae black, second segment tinged with red, about one-fourth length of third, latter slender and reaching nearly to oral margin; arista black, micro-pubescent, slender beyond basal fourth, middle segment barely longer than wide; cheek gray pollinose, about one-twelfth eye height; proboscis short, labella large; palpi red, moderately widened apically; eye large, reaching to vibrissal level, very sparsely short-haired; occiput flat, gray pollinose, rather thinly pale pilose.

Thorax black, gray pollinose with a slight brownish shade on mesonotum; latter vittate; scutellum black, wholly gray pollinose above; chaetotaxy as in *argentifrons,* propleura and postnotal slopes bare; prosternum setose. Wings gray hyaline; veins yellow, third with two hairs near base, others bare; first posterior cell narrowly open shortly before wing tip; bend of fourth vein broadly rounded without stump or fold; last section of fifth vein over one-third length of preceding section; costal spine small; epaulets reddish black; calypters opaque white. Legs red, tarsi blackish; hind tibia ciliate with one longer bristle in row;

mid tibia with one bristle on outer front side near middle; fore tarsi moderately slender, subequal length of tibiae; claws and pulvilli short.

Abdomen wholly red, translucent at sides and usually with a narrow dark median vitta on intermediate segments above, latter silvery pollinose on basal fourth; one pair of good-sized median marginals on first segment and one stouter pair on second; third and fourth segments each with a marginal row, besides a discal row on the last; genitalia retracted, sternites covered. Male unknown.

Length, 5-7 mm.

Holotype female, College Station, Texas, May 21, 1943 (H. J. Reinhard). *Paratypes*: 4 females, same data as type but dated May 17-27, 1943; 1 female, Old Town, Florida, July 11, 1939, (D. E. Hardy), in the Kansas University Museum.

The Florida specimen is considerably smaller than the remainder of the series; it is not in good condition but apparently belongs here.

Pseudochaeta canadensis Brooks

Pseudochaeta canadensis Brks. Can. Ent., LXXVII, 1945, 93.

The description given in the reference cited above is readily accessible and supplies most of the essential details of the species. The type series was reared from *Lexis bicolor* Grot. and an unidentified arctiid.

Nearly fifty field-collected specimens from College Station apparently belong here but differ from the description of the type in a number of items.

Female. Length, 5-8 mm. Vertex 0.31 to 0.34 of the head width; face in direct view slightly narrowed at lower extremity; frontal vitta one-third to one-half parafrontal width; second antennal segment rufescent to yellow, about one-fifth length of third; arista micro-pubescent, thickened on basal fourth to third; outer verticals short but distinct; palpi yellow to brownish; cheek about one-tenth eye height; eye very sparsely short-haired; abdomen black with venter frequently reddish, pollen on intermediate segments above at times extending thinly to middle along median line; anal orifice narrow to slitlike, genitalia retracted; sternites covered; hind tibiae ciliate, middle pair with one anterodorsal bristle; fore tarsi moderately stout, shorter than tibiae.

Male. Length, 5 to 7 mm. Vertex 0.31 to 0.34 of head width, front barely wider at antennae; frontal vitta linelike to one-fourth parafrontal width; third antennal segment broad, seven to eight times length of second; abdomen at most with only a trace of red in ground color of venter; hairs along median line above suberect, particularly on second segment; marginal row on anal segment not differentiated; otherwise, except as mentioned in the original description, similar to female.

Material examined. Fifty-seven specimens as follows: 1 male and 1 female (paratype), Ontario, Canada, July and August, 1942, F. I. Survey 1942; 1 male, Holly Springs, Mississippi, September 27, 1921, no collector's label; 1 male and 47 females, College Station, Texas, April to October, 1917-1943 (H. J. Reinhard); 1 male, Hell Canyon, New Mexico, September 12, 1916 (C. H. T. Townsend); 5 females, Chiricahua Mountains, Arizona, July 4, 1940 (R. H. Beamer and D. E. Hardy). One additional female in the U. S. National Museum labeled "San Jose, C. R., H. Schmidt, XI-11-1928" differs mainly in showing a slight yellowish shade in the mesonotal pollen.

Pseudochaeta argentifrons Coquillett

Pseudochaeta argentifrons Coq. Proc. Acad. Nat. Sci. Phil., 1895, 309.—Revis. Tachinid. 1897, 116.—Allen, Ann. Am. Ent. Soc., 22, 1929, 688.—Brimley, Insects of North Carolina, 1938, 365.—Townsend. Manual of Myiology, Part 11, 1941, 313.

Male. Head wholly silvery pollinose; vertex 0.31 of head width, front equibroad nearly to antennal base; parafrontals somewhat bulged and approximated narrowing the blackish frontal vitta almost to a line before ocelli; frontals decussate to antennae, not very strong; inner verticals straight, barely longer than the two reclinate orbitals; antennae black, short second segment reddish, third rather long and slender, equibroad from base to rounded apex; parafacials

strongly narrowed downward; cheek grooves reddish; eyes large, nearly vertical; palpi usually wholly red but sometimes infuscated basally.

Thorax black, dusted with moderately heavy gray pollen which at times shows a faint yellow tinge on mesonotum, latter vittate; scutellum black, with changeable gray or grayish yellow pollen extending from base to apex; chaetotaxy as listed under generic characters. Wings clear, about twice longer than broad; veins yellow; epaulets black; calypters opaque white. Legs black, not strongly bristled; hind tibia ciliate with one longer bristle in row; mid tibia bearing one stout bristle on outer front side near middle; fore tarsus short but rather slender, four apical segments combined subequal length of the basal; pulvilli small, claws less than half the length of apical segment.

Abdomen black, last three segments gray to yellowish gray pollinose on basal half or more, remainder of each shiny black in direct view; hairs on intermediate segments depressed; chaetotaxy as mentioned above; genitalia reddish black, rather small; forceps moderately long, straight, somewhat wider than thick, divided beyond middle but not divergent and about equibroad from base to tip; accessory process very slender, nearly as long as forceps; fifth sternite divided, lobes blackish, bearing a few small hairs near apical margin.

Female. Front at vertex 0.33 of head width, barely wider at base of antennae; parafrontals subsilvery, the pollen often showing a distinct yellow to golden tinge before vertex; frontal vitta deep red to brown or black, narrowed upwards, at middle one-fourth or more parafrontal width; third antennal segment three to four times length of second; palpi moderately widened apically; eyes very sparsely short-haired; hind tibiae subciliate; genitalia without piercer; otherwise similar to male.

Holotype male and *allotype* female, Charlotte Harbor, Florida (Mrs. A. T. Slosson), in the U. S. National Museum.

Material examined. Twenty-five specimens as follows: 1 male, Florida, Charlotte Harbor, Collection Coquillett; 1 male, North Carolina, "Raleigh Sept."; 5 males and 2 females, Mississippi, Agricultural College, July 24, 1915 (R. W. Harned), September 13, 1921 (H. W. Allen); 5 males and 7 females, Texas, College Station, April to October, 1917-45 (H. J. Reinhard); 1 male and 3 females, Arizona, Pima County, July 28, 1927 (P. A. Readio), Santa Rita Mountains, July 19, 1938 (Jean Russell) and Arivaca, July 26, 1941 (R. H. Beamer).

Variations in coloration in the material just cited may be noted. Eastern specimens generally show a distinct yellowish tinge in the pollen of the front, mesonotum and abdomen; while the limited number of western specimens examined are wholly gray to silvery pollinose. The College Station series shows both extremes in color pattern, including some specimens in which the abdominal pollen is wholly gray but yellowish on mesonotum and parafrontals. There appear to be no constant structural variations to indicate specific distinctions. References to the species from northern states, omitted above, need verification.

Pseudochaeta siminina n. sp.

Male. Front at vertex 0.27 of head width, subparallel to antennae, face widening but slightly downward; head wholly silvery pollinose; parafrontals slightly bulged, with a uniform vestiture of fine black hairs; frontal vitta reddish brown, one-third to one-half parafrontal width; two reclinate orbitals about midway between frontal row and eye margin; inner verticals straight, hardly longer than orbitals; ocellars absent; frontals in a single row, small but differentiated above mid front, lower three or four bristles below antennal base; parafacial bare, narrow, pointed below; clypeus rather deeply sunk; facial ridges bristled about to aristal level; vibrissae stout, on oral margin; antennae as long as face, black, second segment usually reddish, about one-fifth length of third, latter uniform in width from base to rounded apex; arista brownish black, micro-pubescent, slightly thickened on basal third, middle segment short;

proboscis short, labella large; palpi usually jet black but at times brownish, tips moderately widened; cheek in profile very narrow or sublinear, gray pollinose, grooves red; eye distinctly hairy, nearly vertical, descending to vibrissal level; occiput flat, with a moderate vestiture of white hairs.

Thorax and scutellum black, grayish pollinose, with four vittae before suture and five indefinite ones behind; chaetotaxy as in *argentifrons*; prosternum haired at sides; propleura and postnotal slopes bare. Wings hyaline with a slight grayish tinge; veins reddish yellow, third with two hairs near base; hind cross vein bicurved, slightly nearer bend; latter broadly rounded, without stump; first posterior cell narrowly open well before wing tips; last section of fifth vein well over one-third length of preceding; costal spine vestigial; epaulets black; calypters white. Legs black, weakly bristled; hind tibia evenly ciliate; mid tibia with one smallish bristle on outer front side near middle; tarsi slender but shorter than tibiae; claws and pulvilli short.

Abdomen as wide as thorax, moderately tapered apically, with anal segment flattened on either side of a defined median ridge above, shiny black; basal margin of last three segments silvery, the pollen extending thinly beyond middle on second but confined to the narrow anterior edge of third and fourth except at sides and at median line of third; hairs on upper surface longish and suberect; one pair of median marginals on segments one and two, a marginal row on third; anal segment without any differentiated bristles but thickly beset with coarse hairs; genitalia small, bright reddish; forceps long, slender, gently bowed backward at middle, terminating in a blunt forwardly directed tip; accessory process in profile about as thick as forceps and bowed forward at middle; fifth sternite retracted, lobes black.

Female. Front at vertex 0.27 of head width, gradually widening to 0.33 of same at antennal base; head pollen subsilvery with a shade of yellow on parafrontals above; outer verticals developed, two proclinate orbitals about as strong as the two reclinate ones; frontal vitta one-third to one-half parafrontal width; third antennal segment a little over three times second; abdomen broadly ovate, last three segments gray pollinose or subpollinose to hind margin; genitalia retracted, not adapted for piercing; sternites covered.

Length, 6.5-7 mm.

Holotype male and *allotype* female, Amherst, Ohio, July, 1933 (H. J. Reinhard). *Paratypes*: 2 males, same data as type and 1 female, College Station, Texas, September 24, 1920 (H. J. Reinhard).

Pseudochaeta marginalis n. sp.

Male. Front at vertex 0.29 of head width, gradually widening downward into facial angle; head silvery pollinose, parafrontals densely so, clothed with erect black hairs; two reclinate orbitals set just outside frontal row; outer verticals and ocellars absent or vestigial; frontals small and hardly differentiated before ocellar triangle, stouter and decussate downward to antennae, with two to four bristles beneath base of latter; frontal vitta dark reddish brown, fully half as wide as parafrontal; clypeus deeply sunk; facial ridges subvertical, bristled to aristal level; parafacial bare, strongly narrowed downward; antennae subequal facial length, third segment black, nearly five times length of second, which shows a slight reddish tinge; arista black, micro-pubescent, thickened about to middle, basal segments short; proboscis very short, labella large; palpi black, spatulate, tips thickly beset with short black hairs; cheek about one-twelfth eye height; eye large, nearly vertical, descending to vibrissal level, distinctly hairy; occiput clothed with pale or whitish hairs.

Thorax and scutellum black, gray pollinose, mesonotum vittate; chaetotaxy as in *argentifrons*, but the apical scutellars irregular and at times (in two of three specimens) reduced to a single or unpaired suberect bristle set midway between the hindmost lateral pair; prosternum setose; propleura bare; infrascutellum normal in size. Wings hyaline; veins yellow, third with three or four hairs

near base; hind cross vein midway from small cross vein to bend; latter subrectangular, without stump; first posterior cell narrowly open shortly before extreme wing tip; last section of fifth vein over one-third length of proceeding; costal spine minute; calypters white to pale tawny. Legs black; mid tibia with one bristle on outer front side below middle; hind tibia ciliate with one slightly stouter bristle near middle of row; fore tarsus shorter than tibia but not very stout; claws and pulvilli short.

Abdomen as wide as thorax but rather strongly tapered apically, shiny black, with basal fourth or less of last three segments silvery pollinose; hairs on intermediate segments suberect and rather coarse along median line; one pair of median marginals differentiated on first two segments and a marginal row on last two; anal segment above bearing numerous erect hairs intermixed with small bristles near middle; genitalia small, reddish; forceps slender but not very long, united and widened before tip in rear view, tapered to a forwardly bowed blunt tip in profile; accessory process subtriangular, nearly as broad as long; fifth sternite divided, lobes black, not broadly exposed.

Female. Front at vertex 0.27 of head width (one specimen) slightly wider at antennal base; head pollen cinereous to subsilvery; frontal vitta red, about three-fourths parafrontal width; outer verticals not developed; hairlike ocellars present; two proclinate and two reclinate orbitals; frontals obsolete above mid front, third antennal segment three times second; abdomen short ovate, hairs on intermediate segments above depressed; pollen on anterior margin of last three segments extending thinly backward to include basal third in some views, remainder of segments shiny black; genitalia caudoventral; protrusile, terminating in a blunt rounded tip; sternites covered.

Length, 4.5-6 mm.

Holotype male and *allotype* female, College Station, Texas, June 23, 1919, and July 25, 1923 (H. J. Reinhard), respectively. *Paratype,* one male, same data as holotype.

Pseudochaeta clurina n. sp.

Male. Front at vertex 0.28 of head width, equibroad to antennae, face moderately divergent downward; head densely gray to subsilvery pollinose; parafrontals clothed with rather longish fine black hairs; three reclinate orbitals just outside frontal row; ocellars and outer verticals absent; frontal vitta deep velvety brown, narrower than parafrontal; frontal row vestigial above mid front, lowermost two or three bistles below antennal base; antennae wholly black, third segment reaching to oral margin, nearly five times longer than second; arista blackish, micro-pubescent, slightly thickened at base, second segment short; facial ridges subvertical, bristled to upper fourth, clypeus well sunk, blackish, gray pollinose; vibrissae on oral margin; proboscis short, labella fleshy; palpi deep brownish to black, widest near middle and tapered apically, rather thickly black-haired; cheek narrow in profile, less than one-tenth eye height; eye nearly bare, descending to vibrissal level; occiput flat, clothed with pale hairs.

Thorax black, dusted with gray pollen which is interrupted by four rather broad vittae above; scutellum black, the thin gray pollen above changeable in different angles of view; chaetotaxy as in *argentifrons,* but the apical scutellars reduced to hairs; directed horizontally, parallel or slightly divergent; prosternum bristled; propleura and postnotal slopes bare. Wings gray hyaline, reaching beyond tip of abdomen; first posterior cell narrowly open just before extreme wing tip; veins brownish, bare, except third which has one or two hairs near base; hind cross vein slightly nearer bend of fourth, latter broadly rounded, without stump or fold, last section of fifth vein less than one-third preceding section; costal spine minute; epaulets black; calypters opaque white. Legs black, moderately bristled; hind tibiae long ciliate, preceding pair bearing one stoutish bristle on outer front side near middle; tarsi slender and subequal length of tibiae; claws and pulvilli short.

Abdomen slightly elongate, tapering apically, black to near extreme tip

thence red, last three segments with thin gray pollen, extending to hind margin on intermediate ones but the fourth shiny on apical half; hairs above, rather long and coarse, erect; second segment with one pair of large median marginals; third and fourth each with a marginal row, besides a submarginal row and irregular discals on last; genitalia small, reddish black; forceps short, united, tapered to an acute bowed tip; accessory process as long as forceps, moderately broad in profile, narrowed evenly outward to rounded apex; fifth sternite deeply divided at middle, lobes shiny, bearing several long black hairs. Female unknown.

Length, 4-6 mm.

Holotype male, College Station, Texas, April 6, 1944 (H. J. Reinhard). *Paratype,* one male, same data except dated May 26, 1943.

This species is included here provisionally; it does not appear as closely allied to the type as the other forms. The principal differences lie in the cephalic chaetotaxy and structure of the genitalia.

Phaenopsis arabella Townsend

Phaenopsis arabella Tns. Proc. U. S. Nat. Mus., 43, 1915, 362; Manual of Myiology, Part 11, 1941, 309-10.

Dimasicera nitida Tns. Jr. N. Y. Ent. Soc., 23, 1915, 62.

The genotype, *arabella,* is a small shiny black species, which is quite similar to the type species of *Pseudochaeta* in external characters. The question of generic distinctness here may be left open, pending more complete knowledge of the immature stages. *Phaenopsis arabella* is known only from Peru and falls outside the scope of the present paper, but the genus, if eventually accepted, is represented by a closely allied North American species as described below.

Phaenopsis venusta n. sp.

Male. Head about one-third wider than high, subcuneiform in profile; front at vertex 0.28 of head width, hardly widening to middle, thence more rapidly so downward into facial angle; head rather thinly subsilvery pollinose; parafrontals slightly bulged, mostly shining back, clothed with fine erect hairs; frontal vitta black, gradually narrowed from antennal base to ocelli, at middle one-half or more parafrontal width; two reclinate orbitals just outside frontal row; inner verticals straight, outer pair not developed; ocellars absent; frontals small but differentiated above mid front, stronger and decussate downward to antennal base, with about four bristles beneath latter; clypeus deeply sunk; face strongly receding, its ridges vertical, bristled to near upper extremity; parafacial bare, well narrowed below; antennae wholly black, third segment reaching to oral margin, equiboard from base to tip, about seven times length of second; arista black, short pubescent, thickened on basal two-fifths, middle segment short; vibrissae on oral margin; palpi black, the moderately widened tips beset with stubby black hairs; proboscis short, labella large, fleshy; eye thickly haired, nearly vertical, not quite reaching vibrissal level; cheek blackish, about one-eighth eye height; occiput flat, clothed with pale hairs intermixed with black above and below.

Thorax and scutellum black, thinly silvery pollinose, mesonotum subshiny, indistinctly vittate; chaetotaxy as in *Pseudochaeta argentifrons,* but normally with three postsutural dorsocentrals, (four in one specimen); prosternum setose; propleura and postnotal slopes bare; infrascutellum normally developed subshiny black. Wing hyaline with a slight yellowish tinge; veins yellow, bare, except third which bears two hairs near base; first posterior cell narrowly open well before wing tip; bend of fourth vein obtuse, without stump, well before hind margin of wing; hind cross vein moderately oblique, bicurved, a trifle nearer bend than small cross vein; last section of fifth vein over one-third preceding; costal spine vestigial; epaulets blackish; calypters brown. Legs black, with an obscure reddish tinge in ground color of tibiae, rather slender but not elongate; hind tibiae subciliate, middle pair with one median anterodorsal bristle; tarsi slender, claws and pulvilli very short.

Abdomen short, subconic, shiny black, intermediate segments usually pruinose on basal margin; hairs on entire upper surface longish and erect; one pair of median marginals on basal segments but weak on first; marginal row on last two segments, no differentiated discal row on last; genitalia small, blackish; forceps moderately long, united about as wide as thick, in profile tapering to a sharp forward bowed tip; accessory process slender, shorter than forceps, bearing several very minute stubby hairs on anterior side near apex; fifth sternite rather widely divided, lobes shiny blackish, with a few long slender hairs on inner margin.

Female. Front in profile not so prominent at antennal base, at vertex 0.28 of head width, gradually widening forward at facial angle; frontal vitta deep red, narrowed upward, over half parafrontal width at middle; two proclinate and two reclinate orbitals; outer verticals barely differentiated; two or three frontals below antennal base; abdomen ovate, hairs depressed on intermediate segments above and basal fourth to third of each segment silvery, the pollen thin but denser than in male; genitalia retracted, without piercer, fore tarsi moderately stout, with four apical segments short and slightly swollen.

Length, 5 mm.

Holotype male and *allotype* female, College Station, Texas, May 18, 1923 (H. J. Reinhard). *Paratypes*: 3 males and 4 females, same data, except dated April 24 to June 18, 1919-44.

STUDIES ON PARASITES OF THE SPRUCE BUDWORM, *ARCHIPS FUMIFERANA* (Clem.) *

1. Life History of *Apanteles fumiferanae* Viereck (Hymenoptera, Braconidae)

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ABSTRACT

This paper describes all stages of the spruce budworm parasite *Apanteles fumiferanae* Viereck, including the adult. Illustrations of all stages are presented. A short account of the life history of the host is included.

INTRODUCTION

The spruce budworm, *Archips fumiferana* (Clem.), is the most important forest insect in Canada at the present time and vast areas of forest are being ravaged as a result of its continued attack. Waves of budworm attack in the past have subsided, due in some cases to exhaustion of food supply, but in other cases they have died out in the midst of forests apparently suitable for the continuance of attack. The cause of the decline in the latter instances is not known.

Intensive investigations now in progress are designed to elucidate some of the factors involved in the epidemiology of the spruce budworm. Approximately sixty insect parasites of the spruce budworm have been identified in Eastern Canada; very little is known regarding their life histories or their effects on the populations of the host. The two papers in this series represent a contribution toward the study of the life history and identification of two of the important species of parasites of the spruce budworm.

After the essential features of the life history of *Apanteles fumiferanae* had been worked out, the existence of an unpublished manuscript on *Apanteles fumiferanae* by Dr. J. D. Tothill (4) was discovered. This manuscript was in the files of the Forest Insect Laboratory, Fredericton, N. B., and was made available through the courtesy of Mr. R. E. Balch, Officer-in-Charge of the laboratory.

*Contribution No. 2373, Division of Entomology, Science Service, Department of Agriculture, Ottawa.

LIFE HISTORY OF THE HOST

In order to demonstrate the synchronization of the host and parasite life histories, the seasonal development of the spruce budworm may be briefly described as follows:

The adult moths lay their eggs on balsam fir or spruce needles during the latter part of June and the first part of July. After one to two weeks the eggs hatch and the young, first-instar budworm larvae migrate along the branches of the tree seeking a sheltered place in which to spin a small silken hibernaculum. These first-instar larvae are less than one-eighth inch long and do not feed. The moult from first to second instar occurs, in the hibernaculum, from two to three weeks after hatching (personal communication, Dr. S. G. Smith, Forest Insect Laboratory, Sault Ste. Marie, Ontario). The following spring, just before the balsam fir and white spruce buds burst and begin to elongate, the second-instar larvae leave the hibernacula. These larvae at first mine the needles and later attack the succulent young growth of the new shoots. Here they remain until they exhaust the food contained in the bud; they then migrate to another young shoot and continue their feeding. When there are many larvae present, all the new foliage on the tree may be consumed; the larvae then attack the older foliage and may completely defoliate the tree. In the vicinity of Chalk River, Ontario, where most of the material for this paper was collected, the larvae are full-fed by about the first week in June. Pupation then occurs and the adults, as already noted, emerge in late June and early July.

LIFE HISTORY OF APANTELES FUMIFERANAE VIERECK

The following account of the life history of this parasite is based on work carried out by the writer. Where results and observations are at variance with those of Tothill (4) the latter's findings are also included. The general outline which follows is based on the study of the various stages as described in detail below.

Emergence of adult parasites coincides with the hatching of the budworm eggs. Parasite oviposition in the newly hatched budworm larvae occurs at this time. It has been demonstrated by dissection and by rearing of winter-collected larvae that the parasites overwinter in second-stage budworm larvae, in some cases at least as eggs. In the spring they develop in the budworm larvae and emerge as full-fed larvae from fourth- or fifth-stage budworms. Pupation follows and the adults emerge from five to sixteen days later.

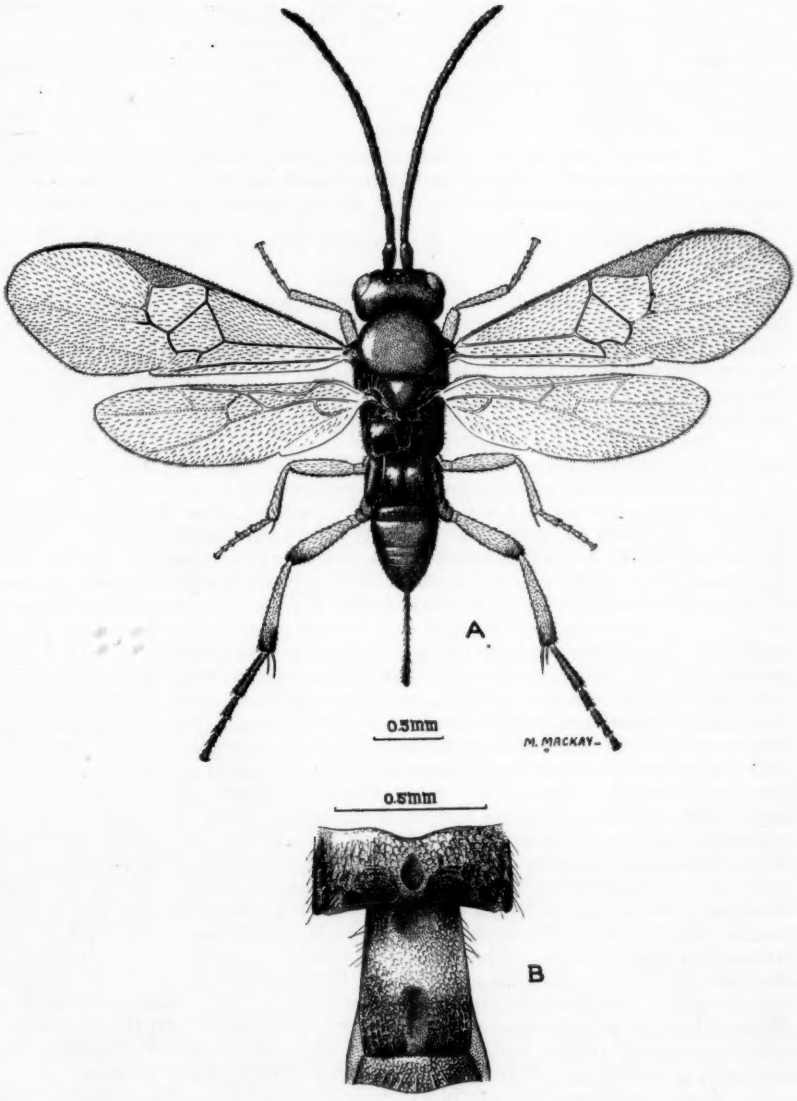
MATERIAL AND METHODS

Material from two main sources was used in this study, viz., (a) overwintering larvae on white spruce foliage collected at Laniel, P. Q., during the winter of 1941-1942 and shipped to London, Ontario, (b) larvae on balsam fir foliage collected in early spring of 1942 near Chalk River, Ontario, and transferred to a screened insectary. Data on length of time spent in the cocoon near Searchmont, Ontario (1943), and Black Sturgeon Lake, north of Port Arthur, Ontario (1944), are also included.

The foliage from Laniel was placed in large emergence cages and the young budworm larvae coming from it were carefully reared in order to determine the general features of the parasite's life history in relation to that of its host.

The bulk of the material on which the descriptions are based was secured at Chalk River, Ontario. Budworm-infested foliage was kept under observation in an insectary and each day a number of budworms were removed from the foliage for rearing and others were preserved in alcohol. Numbers of *Apanteles fumiferanae* third-stage larvae issued from reared material and were allowed to develop to adults in order to ascertain the length of time spent in the later stages of development. The preserved host larvae were later dissected carefully and any parasites they contained were preserved. These parasite larvae were later separated into stages by means of gross microscopical examination and measurements. Measurements of each stage are presented in the accompanying table (Table 1). Typical larvae of each stage were drawn under the microscope.

PLATE VIII.



APANTELES FUMIFERANAE VIER.

A. Adult of *Apanteles fumiferanae* Viereck, showing female from dorsal view.

B. Details of propodeum and first and second tergites from dorsal view.

Table 1
Measurements of *Apanteles fumiferanae* Viereck (in mm.)

Larval stage	Length Range	Average	No. measured	Width Range	Average	No measured
1st	0.249-2.147	1.062	187	0.043-0.570	0.205	198
2nd	1.406-3.648	2.404	178	0.143-0.972	0.523	184
3rd	2.700-4.320	3.438	5	0.522-1.260	0.833	5

Th mouth-parts of first- and third-stage larvae were drawn from material cleared in potassium hydroxide and stained with safranin. The nomenclature of Vance and Smith (5) was adopted in the description of the mouth parts.

Description of the Stages of *Apanteles fumiferanae* Viereck

The Adult

The adult of *Apanteles fumiferanae* was described by Viereck (6) in 1912 from material reared from the spruce budworm. A dorsal view of the female and details of the propodeum and first and second tergites are illustrated in Plate VIII. As the original description of the species is very short and consists merely of a comparison of the species with *A. edwardsii* Riley (2), and as the species has not yet been adequately described, the author has redescribed this insect as follows:

Female. Length 3.5 mm. Length of ovipositor sheath 1.5 mm. Face narrowing very slightly below so that it is slightly narrower at base of clypeus than at the insertion of the antennae, slightly broader than long, with a slight median ridge, densely punctate. Clypeus distinctly separated from face. Vertex sparsely, temples and cheeks more densely punctate; head not rostriform. Disk of scutellum almost flat, about as long as broad at the base, sparsely punctate, rather shining; the posterior polished area on lateral face of scutellum small, extending forward to about the middle of the disk, semicircular in shape, the roughened striate area in front of it very large and conspicuous. Mesoscutum uniformly closely punctate, somewhat shining; mesopleura punctate dorsally and anteriorly, with a distinct groove, shining. Propodeum heavily punctate, with a large oval areola sharply margined, finely punctate within; costulae indistinct; sides of propodeum approximately parallel, the apical angles very prominent. Radius of forewing slightly longer than tranverse cubitus; nervellus curving strongly toward the base of the wing. Posterior coxae finely punctate, shining, lateral surface flattened. Inner spur of hind tibia noticeably longer than outer and about half as long as metatarsus. Abdomen slightly longer than thorax, about two and a half times as long as its extreme breadth. First tergite rectangular, slightly broader at apex than at base, with a rather distinct median longitudinal depression on apical half, twice as long as wide at base, punctate with the punctures somewhat erased in the basal portion, several irregular longitudinal rugulae present on the apical portion at either side of the median longitudinal depression. Second tergite short, transverse, approximately three times as broad at apex as median length, with the sides diverging posteriorly, rather uniformly punctate and with numerous fine irregular longitudinal rugulae. Remainder of the abdomen smooth and shining. Lateral membranous margins along apical half of first tergite, and along length of second tergite and basal half of the third tergite. Ovipositor sheath moderate in width and slightly over half the length of the abdomen.

Black; antennae entirely black; tegulate blackish; wings hyaline; stigma brown with darker anterior margin; thorax and abdomen black; hind coxae black, front and middle coxae dark brownish-black; first two pairs of legs reddish-stramineous; hind femora and tibiae reddish-testaceous with a varying amount of darker fuscous toward the apices; hind tarsi fuscous; ovipositor sheaths black.

Male. Length 2.5 mm. Posterior polished area on lateral face of scutellum slightly smaller than in female, making the roughened striate area in front relatively larger than in the female. Apex of propodeum narrower than base. Posterior coxae not flattened ventrally. Abdomen slightly shorter than thorax,

about three times as long as its extreme breadth. Second tergite about three times as broad as long, sides almost parallel. Remainder of abdomen narrower than in female, tapering to a sharp point; lateral membranous margins along whole of first and second tergites very prominent. Colour as in female.

Apanteles fumiferanae is species 43 in Muesebeck's key (1). *A. solenobiae* Walley (7) which also traces to *fumiferanae* in this key, can be distinguished from *fumiferanae* in having the stigma brown with a large pale spot at the base, the hind femora not fuscous at apices, the mesopleura only narrowly punctate in front with their remaining surface highly polished and impunctate, and the nervellus not strongly curved toward the base of the wing.

A. fumiferanae is very similar to *A. polychrosidis* Viereck but, according to Muesebeck (4, p. 517) the species are distinct, *polychrosidis* having the tegulae yellow, the legs usually darker, the mesoscutum indistinctly punctate and the disk of the scutellum smoother and more polished.

The Egg

The egg (Plate IX, Fig. 1), dissected out of preserved spruce budworm larvae, measures 0.292 mm. in length and 0.098 mm. in width at the widest point. The chorion is light brown in colour, semitransparent, and the developing embryo may be seen within. The egg is slightly curved, and widest near the cephalic end which is broadly rounded and narrows only slightly toward the caudal end. The surface is smooth.

The Larval Stages

First Stage. Just after hatching, the larva measures about 0.25 mm. in length (Plate IX, Fig. 2, A). The body is widest anteriorly and is somewhat wedge-shaped, tapering posteriorly. There is a short spine-like caudal appendage extending posteriorly from the ventral part of the last body segment. The larva is creamy-white in colour.

A later first-stage larva (Plate IX, Fig. 2, B) has, besides the head, twelve body segments and a caudal appendage or anal vesicle. The head appears to be composed of two divisions, the second being much broader than the first. The posterior part of this second head division is the widest part of the body. Behind the head there are twelve fairly regular annular segments and an anal vesicle. Either the tenth and eleventh, or the eleventh and twelfth, or all three of these segments appear to be partially fused. The twelfth, which is probably a composite segment, is slighty wider than the other abdominal segments but is not as wide as the second division of the head. The anal vesicle appears as a rounded projection of the eleventh segment. The spine-like process disappears as the larva grows, finally disappearing before the end of the stage.

The mouth-parts of this stage (Plate IX, Fig. 3) are on the anterior-ventral surface of the first segment of the head. This segment appears as a forward and slightly ventrally projecting lobe of the second segment. Although some of the mouth-parts are sclerotized, they are very lightly pigmented. The mandibles (md) are fairly long, pointed structures with curved blades. The base of the mandible is broad and sits in a shallow concavity laterad of the mouth opening. The mandibular articulations and the supporting head structures are very difficult to interpret. There is, however, a sclerotized ring (pl) around the base of the mandible which the writer takes to be homologous to the pleurostoma, possibly combined with the superior and inferior pleurostomal rami, of other hymenopterous parasites which have more clearly defined first-stage larval mouthparts. The labiostipites (ls) are merely fleshy lobes bordering the mouth opening ventrally. On the labrum (lm) are two small protuberances, the labral processes, which project forward.

As also noted by Tothill, the mandibles of both forms described as first-instar larvae are the same size, indicating that there is no moult between the two

forms which are so different in appearance. Tothill states that the caudal appendage of the first- and second-stage larvae is a blood gill which is simliar in structure and function to the one which he described for *Apanteles hyphantriae* Riley (3).

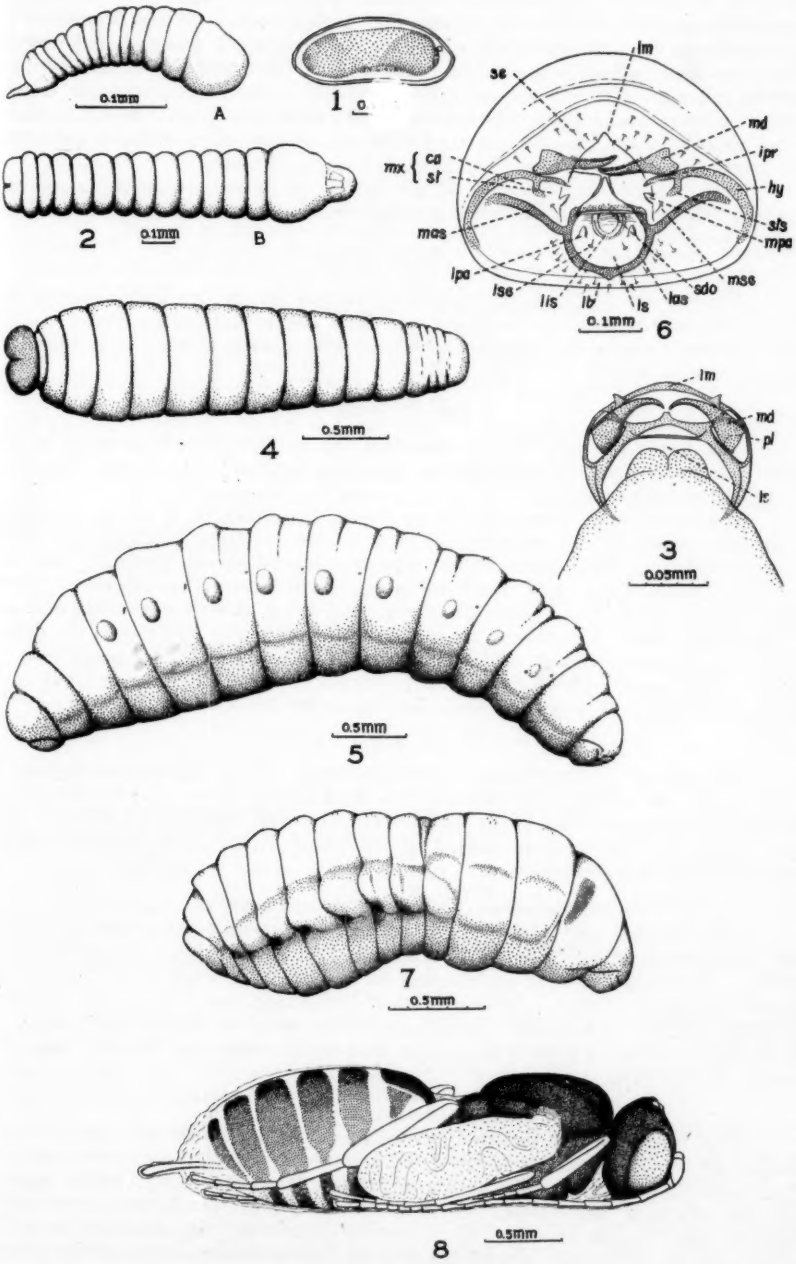
Second Stage. As in the previous stage, the head of the second-stage larva is divided into anterior and posterior portions. From a dorsal view it is somewhat wedge-shaped, tapering anteriorly to a rather blunt end. It is followed by twelve segments. The twelfth segment, which is narrow, bears a large, bilobed caudal appendage or anal vesicle which may become as wide as the body. The anterior half of the body is slightly narrower than the posterior half and the whole is more or less fusiform with blunt ends. (Plate IX, Fig. 4). The body is creamy-white in colour. Tothill notes the presence of visible leg and wing buds and of a well-defined facial plate and remarks that "as the larvae grow the silk glands become more convoluted and noticeable."

No definite sclerotization of the mouth-parts of this stage has been demonstrated and there is no pigmentation in this area. Various treatments failed to make the mouth-parts visible. Tothill states that mandibles are absent in this stage.

Third Stage. The third stage (Plate IX, Fig. 5) appears within the host larva and issues soon after the moult. Just after moulting, the caudal appendage or anal vesicle is still present, but this invaginates during the instar. This is a non-feeding, spinning stage. It is grub-like, curved, and widest at about the level of the seventh to ninth segments. A distinct separation between the dorsal and ventral surfaces is now clearly visible for the first time as a pleural membrane. The head no longer appears to be two-segmented and the head-capsule is roughly hemispherical from a lateral view. The body consists of thirteen segments, the last of which contains the anal opening. Eight pairs of spiracles are visible, occurring on segments two, four, five, six, seven, eight, nine and ten. They are close to the anterior margin of each segment. In the median-lateral line of segments two to ten there is a row of conspicuous round elevations, and on the mid-dorsal surface of segments one to eleven there is a row of short spines.

The mouth-parts of this stage (Plate IX, Fig. 6) are well sclerotized, although not all the structures are present which may occur in the parasitic Hymenoptera. The mandibles (md) are pointed and bear two rows of teeth on the dorsal edge of the blade. They are lightly pigmented. The ventral edge of the base of the mandible articulates with a narrow pigmented bar, the inferior pleurostomal ramus (ipr). No pleurostoma or superior pleurostomal ramus is visible, probably because they are not pigmented, hence the mandibles appear to articulate at only one point. The hypostoma (hy) extends laterally from the inferior pleurostomal ramus and, after a slight upward curve, makes a semicircle ventrally, when viewed anteriorly. A short, curved stipital sclerome (sts) projects ventrally from the point where the hypostoma first curves dorsally. A pigmented U-shaped labiostipital sclerome (las) borders the labiostipites (ls) laterally and ventrally. At the mid-ventral part, this sclerome is enlarged slightly. The dorsal part of the area enclosed by the labiostipital sclerome is wrinkled horizontally and a pigmented strip extends across the open end. Just ventral to this is located the horizontal silk duct opening (sdo). Below the opening lies the ligular sclerome (lis). This is U-shaped and lightly pigmented with the ventral border sometimes indistinct. The labiostipites project beyond the upper open end of the labiostipital sclerome, with the apex more or less pointed. On either side of the ligular sclerome is a labial palpus (lpa), a small conical projection from the labiostipites. Mesad and ventrad of the labial palpi is a pair of labial setae (lse). From the labiostipital sclerome a maxillary sclerome (mas) extends on either side laterally and dorsally into the area enclosed by the semicircular hypostoma, but does not reach as far as the hypostoma. The maxillae

PLATE IX.



APANTELES FUMIFERANAE VIER.

(mx) are bounded dorsally and laterally by the hypostoma, ventrally by the maxillary sclerome. The stipital sclerome, projecting ventrally from the hypostoma, partially divides the maxilla into a cardo (ca) and a stipes (st). On the maxillary stipes is located the maxillary palpus (mpa). Laterad and ventrad of the maxillary palpus is a maxillary seta (mse). No epistoma is visible. A varying number of setae (se) are present on the labrum (lm) and the frontal area. On the head-capsule illustrated there were six pairs of setae dorsal to the mandibles and two pairs laterad of them. A varying number of setae are also present on the labiobase (lb), as shown in the drawing.

Tothill notes that spiracles do not appear to be present in this stage and that mandibles are not visible. These observations are at variance with the findings of the writer.

The Cocoon

The cocoon of *Apanteles fumiferanae* is spun on the tree and is attached to the needles or entangled in webbing and frass left by budworm larvae. It is white in colour and is very opaque. The cocoon measures about 4 mm. in length and 1.5 mm. in width.

The Prepupa

The eonymph very closely resembles the third-stage larva except in the loss of activity and the disappearance of the small median-lateral round elevations on segments two to ten.

The pronymph (Plate IX, Fig. 7), the commencement of which is marked by the first appearance of the imaginal eyes, is quite different in appearance from the eonymph. A slight constriction appears between larval segments one and two and a much deeper and more prominent constriction occurs between larval segments four and five. Thus the developing head, thorax and abdomen are clearly demarcated. The lateral areas of larval segments two to eleven are raised to form a continuous ridge which is especially prominent on segments four to eleven. The pronymph is considerably shorter than the third-stage larva and, like it, is curved. It is creamy-white in colour.

The Pupa

The exarate pupa of *Apanteles fumiferanae* (Plate IX, Fig. 8) at first is creamy-white in colour with conspicuous dark-brown eyes. Later the head, dorsum and venter of the thorax become blackish and finally the abdomen and legs assume the colour characteristic of the adult. The pupa measures about three millimetres in length.

LENGTH OF TIME SPENT IN THE COCOON

Data on this part of the life history of *Apanteles fumiferanae* are available from Chalk River (1942), Searchmont (1943) and Black Sturgeon Lake (1944). At Chalk River, 31 males spent an average of 12 days in the cocoon; 41 females averaged 12 days. At Searchmont the period was 8 days for 11 males and 12.5 days for 15 females. Twenty-six males spent an average of 12 days in the cocoon at Black Sturgeon Lake and 24 females from that locality spent an average of 11.5 days.

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EXPLANATION OF PLATE IX.

Immature Stages in Life History of *Apanteles fumiferanae* Viereck.

Figure 1. Egg, lateral view.
2. First-stage larva.
A. just after hatching, lateral view.
B. at end of instar, ventral view.
3. Cephalic skeleton of first-stage larva.
4. Second-stage larva, dorsal view.
5. Third-stage larva, lateral view.
6. Cephalic skeleton of third-stage larva.
7. Pronymph, lateral view.
8. Pupa, female, lateral view.

SYMBOLS USED IN THIS PAPER

ca — maxillary cardo
hy — hypostoma
ipr — inferior pleurostomal ramus
las — labiostipital sclerome
lb — labiobase
lis — ligular sclerome
lm — labrum
lpa — labial palpus
ls — labiostipites
lse — labial seta
mas — maxillary sclerome
md — mandible
mpa — maxillary palpus
mse — maxillary seta
mx — maxilla
pl — pleurostoma
sdo — silk duct opening
se — seta
spr — superior pleurostomal ramus
st — maxillary stipes
sts — stipital sclerome

BOOK NOTICES

A MONOGRAPH OF THE BEETLES ASSOCIATED WITH STORED PRODUCTS. Volume I, by H. E. Hinton, Assistant Keeper, Department of Entomology, British Museum (N. H.). VIII and 443 pages, 503 figures, 1945. British Museum (N. H.), London, England. Price 30 shillings.

The exigencies of the food situation in Britain in 1940 intensified interest in the pests of stored products. As "Beetles are by far the most important and most numerous order of insects attacking stored products", and "about six hundred species representing some thirty-four families have been found associated with stored products in various parts of the world", a comprehensive study and revision of coleopterous stored products pests was initiated.

In 1943 Dr. Hinton was lent to the Food Ministry by the Department of Entomology of the British Museum. Primarily he was responsible for insect iden-

tification and the training of inspectors. In his spare time he prepared this monograph on approximately 200 pests of stored products belonging to 12 families. In this monograph 175 species, belonging to the families Carabidae, Staphylinidae, Nitidulidae, Lathridiidae, Mycetophagidae, Colydiidae, Murmidiidae, Endomychidae, Erotylidae, Anthicidae, Cryptophagidae and Dermestidae are described and an additional 25 species are included in the keys. Keys to adults are given for all families, except the Endomychidae. Keys to larvae are included, except for the families Mycetophagidae, Colydiidae, Murmidiidae, Endomychidae and Anthicidae. Keys to pupae are included under the Nitidulidae and Lathridiidae. Eight species and four genera have been relegated to synonymy. Synonymy as listed for various species has been restricted to names found in economic and biological literature and is therefore incomplete.

The bibliography of some 26 pages includes over 850 references, chiefly relating to life history and habits and control of the various species. Facts relating to the life history and habits of each species are summarized under the species name. No attempt has been made to summarize control measures.

R. H. Ozburn

INSECT DIETARY, by Professor Charles T. Brues. XXVI + 466 pages, 68 figures, 22 plates, 1946. Harvard University Press, Cambridge, Mass. $5.00.

Most entomologists are familiar with the feeding habits and food of a variety of insects. It has remained, however, for Professor Brues to organize, in book form, much of the available knowledge in this field of entomology.

In this book the author has discussed in a generalized, semi-popular manner the diverse relations of insects to their food. At the same time sufficient detail has been included to enable the reader to relate the food habits of insects to those of other animals, to such general biological considerations as symbiosis, parasitism and gall formation, and to some extent to insect evolution.

The first two chapters, "The Abundance and Diversity of Insects" and "Types of Food Habits; Their Relation to Structure and Environment", serve as a basis for more detailed discussion of food habits under the headings of "VEGETARIAISM AND CARIVORISM". Under Vegetarianism, "Herbivorous Insects", "Gall Insects" and "Fungi and Microbes as Food; Symbiosis with Microorganisms" are each dealt with at chapter length. Under Carnivorism "Predatory Insects", "Parasitism", "Blood-sucking Insects and other External Parasites", "Entomophagous Parasites and other Internal Parasites" and "Insects as Food for Man and Other Organisms" are similarly discussed. Several pages, including some 2800 references to original papers, are included at the end of each chapter. An index to authors (15 pages) and to subjects (9 pages) complete the work.

This volume should be of interest and practical value as a reference to professional entomologists, and be welcomed by the group of individuals commonly termed "naturalists".

R. H. Ozburn

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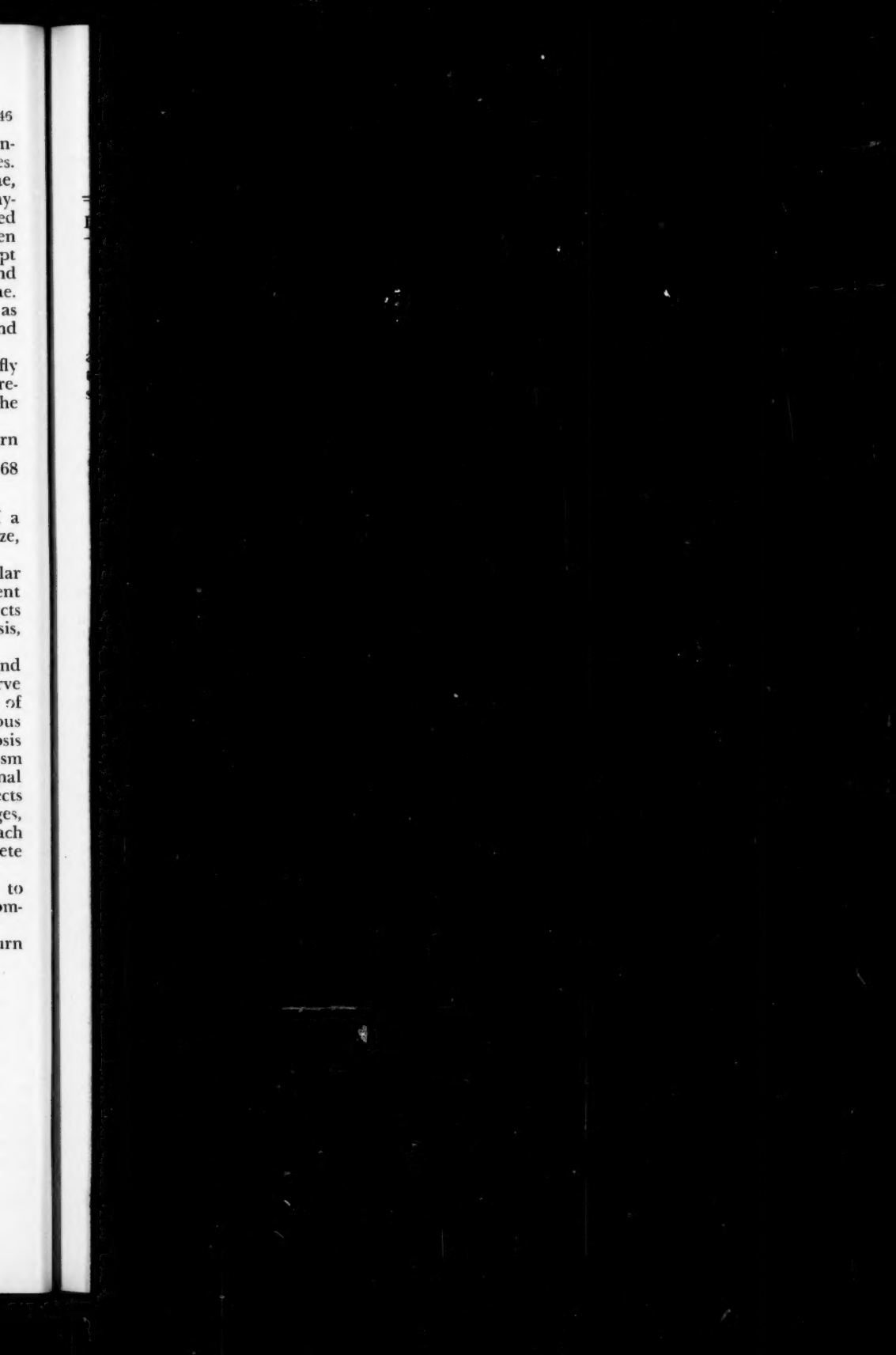
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